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SUBJECT: Apollo Mission Launch Coverage
Provided by an Insertion Ship at
25° N, 40° W for Launch Azimuth
Range 72°-108° - Case 320

DATE: April 1, 1969

FROM: J. P. Maloy

MEMORANDUM FOR FILE

A study was made to determine the insertion coverage for an Apollo Saturn V Mission provided by a ship located at latitude 25° N; longitude 49° W for the launch azimuth range of 72° - 108° . This was the location of the insertion ship for the Apollo 8 mission that had an initial launch azimuth of 72° .

Using the necessary inputs from an MSFC document¹, five launch trajectories for launch azimuths of 72°, 81°, 90°, 99° and 108° were generated. These trajectories in turn were combined with tracking station information in the Bellcomm TRACK 2 computer program to calculate the coverage provided by these stations during the launch phase and for several minutes after insertion.

The results of the study were compared and found to be in very close agreement with MSC data in the attached Figure 1². It was not possible to get comparable results to elevation angles other than 0° using this method since the basic inputs after insertion from the MSFC document were not that detailed. It could reasonably be assumed that since the data at 0° elevation agreed so closely with MSC output that the data for the other elevation angles would not be significantly different.

The figure shows that a ship at 25° N; 49° W location would provide more than three minutes of coverage after insertion to 0° elevation angle from the ship to the space vehicle for all launch azimuths from 72° to 108°. (It is presumed that the keyhole associated with the ship's antenna, a half angle of about 15°, would not interfere with continuous communications. The keyhole is relatively small and the ship could be maneuvered to a favorable position prior to a launch window so that any gaps in coverage could be avoided). Communications could be accomplished

¹Enclosure 5 to Memorandum "AS-503 C' Operational Trajectory Analysis - Option 1 December Launch Opportunity," from MSFC, dated September 24, 1968.

²MSC data taken from MSC Internal Note #68-FM-252.

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(NASA-CR-106700) APOLLO MISSION LAUNCH
COVERAGE PROVIDED BY AN INSERTION SHIP AT 25
DEG N, 40 DEG W FOR LAUNCH AZIMUTH RANGE 72
DEG TO 108 DEG (Bellcomm, Inc.) 4 p



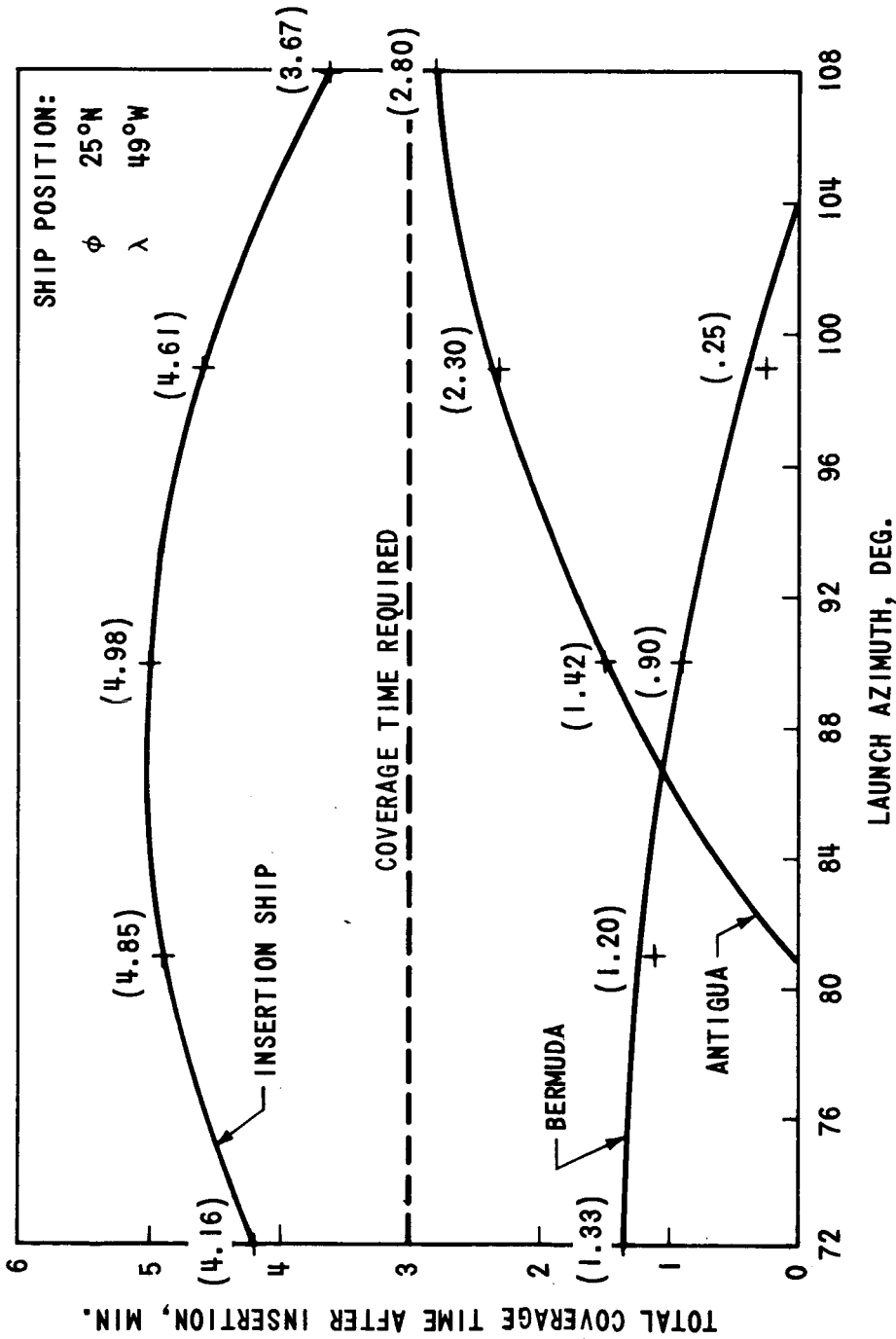
for the full time period, i.e. from insertion until the space vehicle was on the horizon and the track could be determined using telemetered data from the on board guidance computer. Angle tracking, however, could not be performed down to the horizon. Sufficiently accurate angle data would be difficult to obtain below an elevation angle of 3° .

Figure 2, taken from the same MSC document shows what coverage times are available down to 5° elevation angle for the full range of launch azimuths. From about 74° to 102° launch azimuth three minutes of tracking is obtained which is known to be adequate for orbit determination. At the extremes of the launch azimuth range, i.e. from 72° to 74° and from 102° to 108° , three minutes of coverage is not available. The worst case lies between 107° and 108° where the coverage time becomes less than a minute and a half. It has been stated that one and a half minutes of tracking data above a 3° elevation angle after insertion may be sufficient to determine the space vehicle insertion orbit. If this is so then one ship at 25° N; 49° W might fulfill the angle tracking requirement over the entire range of launch azimuths.

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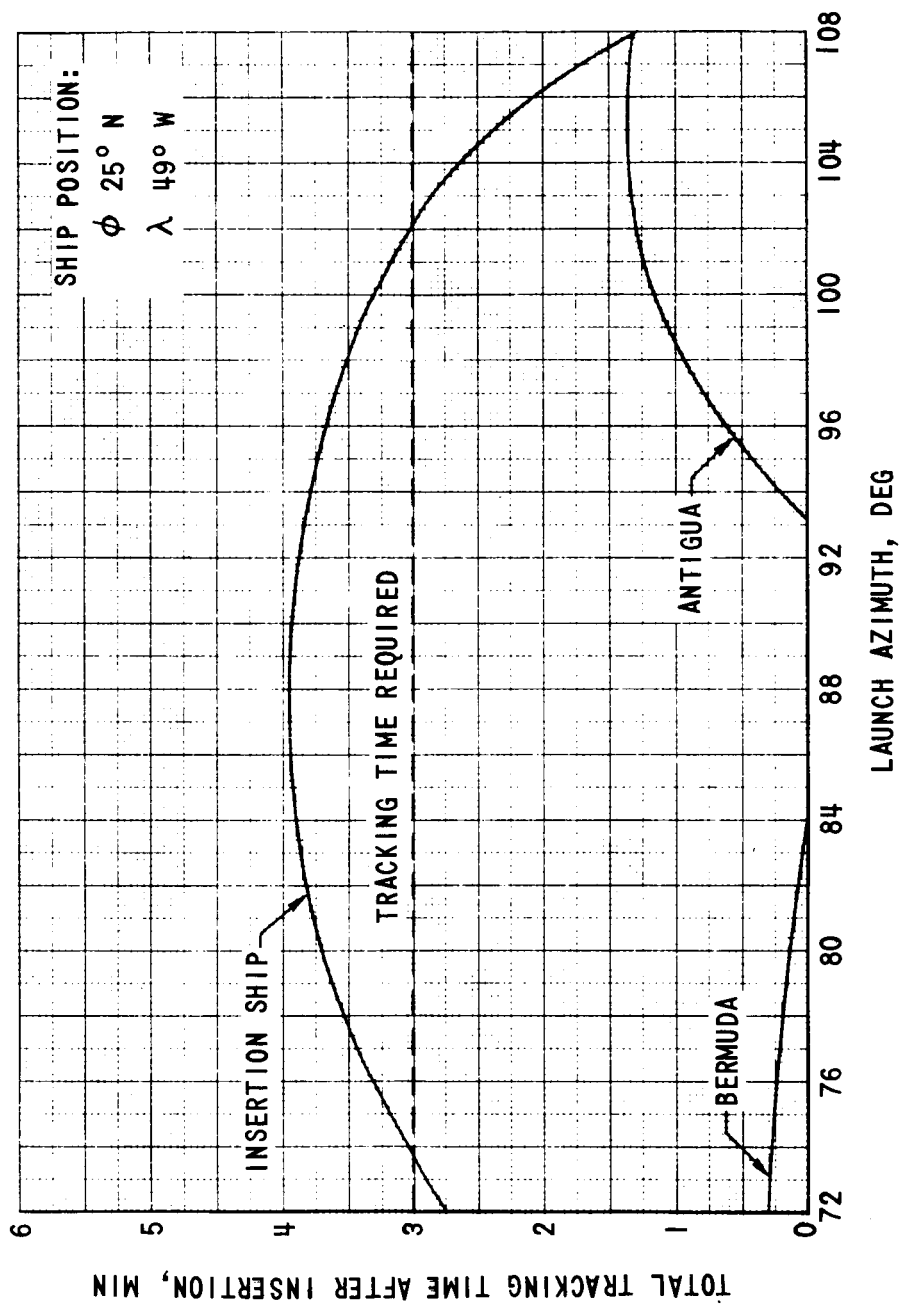
Attachments
Figures 1, 2



LEGEND: (1.38) - INDICATES COVERAGE TIME AFTER INSERTION DERIVED FROM BELLCOMM STUDY.

+ - MSC RESULTS

FIGURE 1 - COMPARISON OF BELLCOMM AND MSC POST INSERTION COVERAGE TIMES FOR INSERTION SHIP AT 25°N; 49°W. (REFERENCE MSC INTERNAL NOTE #68-FM-252, 10/25/68). TOTAL COVERAGE TIME AFTER EARTH ORBIT INSERTION TO MINIMUM ELEVATION OF 0°



(b) TOTAL TRACKING TIME AFTER EARTH ORBIT INSERTION FOR MINIMUM ELEVATION OF 5°

FIGURE 2

NOTE: TAKEN FROM MSC INTERNAL NOTE #68-FM-252, 10/25/68

BELLCOMM, INC.

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